

Paleoclimate insights from noble gases in groundwater of the Açu aquifer in northeastern Brazil

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Dissolved noble gas concentrations in groundwater are well-established paleoclimate proxies. Noble gas temperature (NGT) is a measure for mean annual soil temperatures [1], whereas excess air (EA) amount, measured by the neon oversaturation, yields insights into past water table fluctuations. A well-known previous study in the Piauí Province, Brazil [2], revealed a 5°C temperature difference between the Holocene and the Last Glacial Maximum (LGM), which was increased to 7°C in a recent re-analysis [1]. Another re-evaluation of this data set highlighted a negative correlation between reconstructed EA amounts and NGTs [3].

Here, we present new noble gas results from the Potiguar Basin, situated in semi-arid northeastern Brazil, consisting of two important hydrogeological systems, the porous Açu aquifer and the karstic Jandaíra aquifer. He, Ne, Ar, Kr, and Xe concentrations were measured in groundwater samples collected from the Açu aquifer to calculate NGT and EA. A combination of ¹⁴C, radiogenic helium and distance to the recharge area was used to obtain a qualitative estimate for groundwater ages. Stable water isotopes were analyzed to determine groundwater flow patterns.

NGT differences of up to 10°C between presumably younger samples from the recharge area in the aquifer outcrops, and older, downstream samples can be observed. Older groundwater samples, potentially linked to recharge during the LGM, show high levels of EA, indicating greater fluctuations in groundwater levels in the past. These results generally confirm the findings from the nearby Piauí Province [2]. The observed temperature differences between young and old groundwater samples in the Potiguar Basin somewhat exceed even the highest previously reported LGM cooling of 7°C for the neighboring region and of 6°C for low-latitude regions globally [1]. Furthermore, our results clearly confirm the negative correlation between EA amount and NGT in northeastern Brazil. This trend has also been observed at other semi-arid study sites [3] and suggests a wetter LGM climate with stronger water table fluctuations for these regions.

[1] Seltzer, A., et al., 2021. *Nature* 593: 228–232.

[2] Stute, M., et al., 1995. 379–383.

[3] Negele, S., et al., 2023. In: Goldschmidt 2023 Conference, Lyon, Abstract 18239.